

# IVISTA

## China Intelligent Vehicle Index

No.: IVISTA-SM-ICLHNP-RP-A0-2023

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### Intelligent Cruise Index Navigation Pilot System Rating Protocol (Highway)

(Version 2023)

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Published by **China Automotive Engineering Research Institute Co., Ltd.**

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# Intelligent Cruise Index Navigation Pilot System Rating Protocol (Highway)

## 1 Scope

This document specifies the evaluation method for IVISTA China Intelligent Vehicle Index - Intelligent Cruise Index - Navigation Pilot System (Highway).

## 2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the dated edition applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB 1589-2016 Limits of Dimensions, Axle Load and Masses for Motor Vehicles, Trailers and Combination Vehicles

GB 5768.2-2022 Road Traffic Signs and Markings - Part 2: Road Traffic Signs

GB 5768.3-2009 Road Traffic Signs and Markings - Part 3: Road Traffic Markings

GB 5768.4-2017 Road Traffic Signs and Markings - Part 4: Work Zone

GB 5768.5-2017 Road Traffic Signs and Markings - Part 5: Speed Limit

GB/T 20608-2006 Intelligent Transportation Systems - Adaptive Cruise Control Systems - Performance Requirements and Test Procedures

GB/T 24720-2009 Traffic Cones

GB/T 40429-2021 Taxonomy of Driving Automation for Vehicles

JTG H30-2015 Safety Work Rules for Highway Maintenance (Industry Standard of the People's Republic of China)

ISO 21448 Road vehicles - Safety of the intended functionality

ISO 34502 Road vehicles - Engineering framework and process of scenario-based safety evaluation

ECE R157 Uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping System

## 3 Evaluation Method

### 3.1 Overview

The total score of the navigation pilot system (highway) test is 110 points, covering three parts: closed field test, open road test and simulation test. Among them, the total score of the closed field test is 100 points, that of the open road test is 100 points and that of the simulation test is 10 points. The final score of the navigation pilot system (highway) test is calculated as follows:

The score of the navigation pilot system (highway) test = min {score of closed field test, score of open road test} + score of simulation test

### 3.2 Scoring of closed field test

3.2.1 The total score of the closed field test is 100 points, covering 7 test scenarios. The specific scoring method is shown in Table 1.

**Table 1 Scoring of Closed Field Test**

Type	Scenario	Full Score	Maximum Speed of SV for Collision Avoidance < 60 km/h	Maximum Speed of SV for Collision Avoidance = 60 km/h	60 km/h < Maximum Speed of SV for Collision Avoidance < 120 km/h	Maximum Speed of SV for Collision Avoidance ≥ 120 km/h	Penalty Item
Basic scenarios	Stationary passenger car ahead	14	0	8.40	$y = \frac{7}{75}x + 2.80$ Where, y - score, accurate to two decimal places x - maximum speed of sv for collision avoidance	14.00	If the SV adopts a lane change strategy to avoid a collision, it is required to turn on the turn signal before changing lanes. If the turn signal is not turned on, 5 points will be deducted from the score of the corresponding test scenario
	Forward passenger car being stationary (on a straight lane) - target vehicle (TV) being skewed	14	0	8.40		14.00	
	Stationary passenger car ahead (on a curve)	14	0	8.40		14.00	
	Passenger car TV cut-in	14	0	8.40		14.00	
	Passenger car TV cut-out	14	0	8.40		14.00	
Challenging scenarios	Traffic cone avoidance	15	0	9.00	$y = \frac{1}{10}x + 3.00$ Where, y - score, accurate to two decimal places x - maximum speed of sv for collision avoidance	15.00	
	Stationary anti-collision buffer vehicle ahead	15	0	9.00	15.00		

3.2.3 For specific test scenarios, the SV needs to pass all test cycles corresponding to different SV speed points in this scenario to obtain the corresponding score for the SV speed point.

3.2.4 The passing requirement for specific test cycles is that the SV does not collide with the TV or target object.

### 3.3 Scoring of open road test

3.3.1 The total score of the open road test is 100 points, including scenario tests and bonus and penalty items. The final total score shall not exceed 100. The specific scoring method is shown in Table 2.

3.3.2 Final score of open road test =  $\sum$  (score under specific test conditions) \* HNP function activation percentage - penalty + bonus points.

**Table 2 Scoring for Functional Completion Test**

Type	Scenario		Test Condition	Full Score	
Basic scenarios	Highway	Within a section	Stop-and-go traffic	Stop-and-go traffic	5
			Tunnel passing	Tunnel passing	5
		Navigation for lane change at the lane end	Driving cycle 1: no surrounding vehicle in front of the SV's lane and in the adjacent lane	5	
			Driving cycle 2: no surrounding vehicle in the SV's lane and 1 surrounding vehicle in the adjacent lane	5	
			Driving cycle 3: no surrounding vehicle in the SV's lane and 2 surrounding vehicles in the adjacent lane	5	
			Driving cycle 4: 1 surrounding vehicle in the SV's lane and no surrounding vehicle in the adjacent lane	5	
			Driving cycle 5: 1 surrounding vehicle ahead in the SV's lane and 1 surrounding vehicle in the adjacent lane	5	
			Driving cycle 6: 1 surrounding vehicle ahead in the SV's lane and 2 surrounding vehicles in the adjacent lane	5	
		Highway off-ramp (with 0/1 surrounding vehicle)	Driving cycle 1: no surrounding vehicle in front of the SV's lane and in the adjacent lane	5	
			Driving cycle 2: no surrounding vehicle in the SV's lane and 1 surrounding vehicle in the adjacent lane	5	
			Driving cycle 3: 1 surrounding vehicle in the SV's lane and no surrounding vehicle in the adjacent lane	5	
			Route selection in ramp	Driving cycle 1: no surrounding vehicle in front of the SV's lane and in the adjacent lane	5
				Driving cycle 2: no surrounding vehicle in the SV's lane and 1 surrounding vehicle in the adjacent lane	5
			Highway on-ramp (with 0/1 surrounding vehicle)	Driving cycle 1: no surrounding vehicle in front of the SV's ramp and in the adjacent lane	5
				Driving cycle 2: no surrounding vehicle in front of the SV's ramp and 1 surrounding vehicle in the adjacent lane	5
				Driving cycle 3: 1 surrounding vehicle in front of the SV's ramp and no surrounding vehicle in the adjacent lane	5
			Challenging scenarios	Highway off-ramp (with 2/3 surrounding vehicles)	Driving cycle 1: 1 surrounding vehicle in front of the SV's lane and 1 surrounding vehicle in the adjacent lane
		Driving cycle 2: 1 surrounding vehicle in front of the SV's lane and 2 surrounding vehicles in the adjacent lane			5
		Highway on-ramp (with 2/3 surrounding vehicles)		Driving cycle 1: 1 surrounding vehicle in front of the SV's ramp and 1 surrounding vehicle in the adjacent lane	5
				Driving cycle 2: 1 surrounding vehicle in front of the SV's ramp and 2 surrounding vehicle in the adjacent lane	5

3.3.3 The functional completion of the VUT under each test cycle shall be scored according to 3 levels based on the driving automation levels of the SV to fulfill the driving task (see Annex A for detailed rules for scoring specific test cycles):

a) Level 1: The SV successfully fulfills the driving task at Level 2 driving automation without functional degradation or driver takeover alarm, and the scoring rate under the corresponding test cycles is 100%;

b) Level 2: The SV fulfills the driving task at Level 1 or 0 driving automation and can remind the driver of the takeover with ease; the scoring rate of the corresponding test cycles is 60%;

c) Level 3: The SV fails to fulfill the driving task and does not remind the driver of the takeover; no point will be scored for the corresponding test cycles.

3.3.4 For a specific test cycle, if this specific condition occurs repeatedly in the open road test, multiple test results shall be scored separately, and the average value of the remaining test scores (accurate to 2 decimal places) shall be taken as the final score of this test cycle after the lowest score is removed as per the 20% proportion.

**Note:** If 20% of the number of tests under this test cycle is non-integer, it shall be rounded off to the nearest integer; if it is less than 1, it shall be taken as 1.

3.3.5 The HNP function activation percentage is the proportion of the actual mileage with the SV's HNP function activated to the total mileage covered with the SV's HNP function activatable theoretically. The specific calculation method is as follows:

HNP function activation percentage = actual mileage with HNP function activated/total mileage with HNP function activatable \*100%

3.3.6 During the whole open road test, if the SV has the following conditions, the corresponding score will be deducted from the score of the open road test as a penalty. The final total penalty shall not exceed 20 points at most, as shown in Table 3.

**Table 3 Penalty Item**

		Penalty Item	Deducted Points
Highway	Within a section	Beyond the road speed limit	2
		Lane change without the turn signal on	2
		Crossing a solid line	2
		With the road clear, the SV runs below the minimum speed limit for more than 30 s in the road section.	2
		Unexpected braking or steering due to misidentification by the sensing system	3
	At a ramp	Crossing a solid line	2
		Unexpected braking or steering due to misidentification by the sensing system	3

**Note 1:** If the system sends a confirmation request for speed limit change, the tester shall confirm within 2 s after the system sends the request.

**Note 2:** If the SV triggers the same penalty item multiple times on the same road section or position of the open road, only one penalty will be imposed.

3.3.7 Throughout the open road test, if the SV successfully implements the following functions, the corresponding score will be added to the open road test score as bonus points, as shown in Table 4.

**Table 4 Bonus Item**

Bonus Item	Bonus Points
The TV ahead of the SV slows down, and the SV intelligently changes its lane	(1 point)
Intelligent avoidance of large vehicles on the side	(1 point)

**Note 1:** During the actual test, if the SV successfully realizes one of the functions in the table above, additional points will be given once and will not be accumulated.

### 3.4 Scoring of simulation test

3.4.1 The total score of the simulation test is 10 points, and the scoring method for basic scenario test is the same as that for the closed field test. See 3.4.4 and Table 5 for specific scoring methods for the scenario generalization test.

3.4.2 In this protocol, the consistency between the results of the simulation test and those of real vehicle closed field tests is verified through the basic scenario test of the simulation test, and the confidence  $Re$  of the simulation test is obtained. The specific calculation method of  $Re$  is as follows:

$$Re = \left(1 - \frac{\sum (\text{driving cycle with inconsistent results})}{14}\right) \times 100\%$$

**Note 1:** In the 7 test scenarios for the basic scenario of the simulation test, select the test cycles of the linear speed points declared by the closed field test enterprise and the qualified linear speed points (60 km/h) corresponding to each scenario. There are a total of 14 test cycles, which is the denominator in the above formula.

**Note 2:** For the 14 test cycles in Note 1, if the passing capability of simulation test results is different from that of closed field test results, this condition is considered a driving cycle with inconsistent results.

**Note 3:** For the same test cycle, if full scores are obtained for both the simulation test and closed field test, the passing capacity is considered the same.

3.4.3 Final score of simulation test =  $\sum$  (score of scenario generalization test)  $\times Re$ .

3.4.4 In the scenario generalization test, the scoring method for each test cycle is as follows:

- a) Pass (100% score): When the test is valid, the SV stops or turns to avoid collision.
- b) Non-compliance (50% score): When the test is valid and the SV does not collide:
  - The SV crosses a solid line, or continuously crosses the line for more than 8 s;
  - The turn signal is not turned on before the SV steering avoidance.
- c) Fail (no points): One of the following conditions is met:
  - The SV collides with the TV.

**Table 5 Specific Scoring for Generalization Test of Simulation Test Scenarios**

Test Scenario	Number of Test Cycles	Full Score for Test Scenario	Full Score for Each Test Cycle
Stationary TV ahead	24	1	1/24
Stationary passenger car ahead (on a curve)	17	1	1/17
Passenger car TV cut-in	17	1	1/17
Passenger car TV cut-out	13	1	1/13
Obstacle avoidance	13	1	1/13
Stationary special vehicle ahead	24	1	1/24
Emergency braking of vehicle ahead	12	1	1/12
TV cut-in at the moment of obstruction of the SV's field of view	14	1	1/14
Construction area passing	14	1	1/14
On-ramp	12	1	1/12

## Annex A

### Scoring Rules for Open Road Test

#### A.1 Stop-and-go traffic

- a) Level 1 (scoring rate: 100%): The SV automatically follows the vehicle ahead in the same lane in a congested section to complete the driving task of the specified congested section, without functional degradation or driver takeover alarm.
- b) Level 2 (scoring rate: 60%): The SV cannot automatically follow the vehicle ahead in the same lane in a congested section to stop and go, and the driver needs to confirm (by pressing the button or gently depressing the accelerator pedal) or the system needs to remind the driver to follow.
- c) Level 3 (no points): The SV cannot automatically follow the vehicle ahead in the same lane in a congested section to stop and go, and the system does not remind the driver to follow.

#### A.2 Tunnel passing

- a) Level 1 (scoring rate: 100%): The SV enters the tunnel entrance and exits after passing through the tunnel, during which no functional degradation or driver takeover alarm occurs, and the navigation pilot system (highway) continuously controls the SV laterally and longitudinally.
- b) Level 2 (scoring rate: 60%): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:
- The SV experiences functional degradation before entering the tunnel, and gives a driver takeover alarm not less than 5 s before entering the tunnel;
  - The SV experiences functional degradation when passing through the tunnel, and gives a driver takeover alarm not less than 5 s before the degradation.
- c) Level 3 (no points): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:
- The SV experiences functional degradation or exits the function before entering the tunnel, without giving a driver takeover alarm.
  - The SV experiences functional degradation or exits the function before entering the tunnel, and gives a driver takeover alarm less than 5 s before entering the tunnel;
  - The SV experiences functional degradation or exits the function when passing through the tunnel, without giving a driver takeover alarm;
  - The SV experiences functional degradation or exits the function when passing through the tunnel, and gives a driver takeover alarm less than 5 s before entering the tunnel.

**Note:** Functional degradation only refers to the downgrade of the navigation pilot system (highway) from Level 2 to Level 1 or 0 driving automation, excluding function switching within Level 2 driving automation and prompts, such as the subject vehicle (SV) reminding the driver to focus on driving.

#### A.3 Navigation for lane change at the lane end

- a) Level 1 (scoring rate: 100%): The SV can identify surrounding vehicles in the same lane and the adjacent lane and can change to lanes without lane reduction, without functional degradation or driver takeover alarm; when the SV starts lane change or the system prompts the driver to confirm lane change, the THW between the front of the SV and the end of the lane is not less than 5 s.
- b) Level 2 (scoring rate: 60%): The SV can identify surrounding vehicles in the same lane and the adjacent lane. When the THW between the head of the SV and the end of the lane is not less



than 5 s, the system sends a takeover request, and the driver completes the lane change.

c) Level 3 (no points): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:

- When the SV starts lane change or the system prompts the driver to confirm lane change, the THW between the front of the SV and the end of the lane is less than 5 s;
- The system sends a takeover request to the driver, but the THW between the front of the SV and the end of the lane is less than 5 s at this time;
- The SV fails to identify the surrounding vehicle, and the driver is forced to take over in the event of risk of collision during lane change;
- The SV does not change its lane to the adjacent lane, and the system does not send a lane change confirmation request or takeover request, causing the wheel to cross a solid line or the vehicle to be subject to a forced takeover by the driver or entering the emergency lane.

#### **A.4 Highway off-ramp**

a) Level 1 (scoring rate: 100%): The SV can identify the surrounding vehicle in the same lane or the adjacent lane, and can completely change its lane from the main road of the highway to the ramp, without functional degradation or driver takeover alarm. In addition, when the SV starts lane change or the system prompts the driver to confirm lane change, the wheel does not cross a solid line or diversion line, and the THW between the SV front and the ramp exit is not less than 5 s.

b) Level 2 (scoring rate: 60%): The SV can identify the surrounding vehicle in the same lane or the adjacent lane, and when the THW between the SV front and the ramp exit is not less than 5 s, the system sends a takeover request, and the driver completes the lane change.

c) Level 3 (no points): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:

- When the SV starts lane change or the system prompts the driver to confirm the lane change, the THW between the SV front and the ramp exit is less than 5 s;
- The system sends a takeover request, but the THW between the SV front and the ramp exit is less than 5 s at this time;
- The SV fails to identify the vehicle in the adjacent lane, and the driver is forced to take over in the event of risk of collision during lane change;
- The SV does not change its lane to the ramp and the system does not send a lane change confirmation request or takeover request, causing the wheel to cross a solid line or the vehicle to be subject to a forced takeover by the driver;
- Any running wheel of the SV crosses the diversion area;
- Although the SV successfully changes its lane at the ramp exit, it does not enter the ramp.

#### **A.5 Route selection in ramp**

a) Level 1 (scoring rate: 100%): The SV can identify the surrounding vehicle in the adjacent lane and can enter the correct route in the ramp according to the navigation information, without functional degradation or driver takeover alarm; when the SV starts lane change or the system prompts the driver to confirm lane change, the THW between the front of the SV and the starting point of the diversion area is not less than 5 s.

b) Level 2 (scoring rate: 60%): The SV can identify the surrounding vehicle in the adjacent lane, and when the THW between the front of the SV and the starting point of the diversion area is not less than 5 s, the system sends a takeover request, and the driver drives into the correct ramp

guided by the navigation information.

c) Level 3 (no points): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:

- When the SV starts lane change or the system prompts the driver to confirm lane change, the THW between the front of the SV and the starting point of the diversion area is less than 5 s;
- The system sends a takeover request, but the THW between the front of the SV and the starting point of the diversion area is less than 5 s at this time;
- The SV fails to identify the surrounding vehicle in the same lane or the adjacent lane, and the driver is forced to take over in the event of risk of collision during lane change;
- The SV does not change its lane to the correct path guided by the navigation information in the ramp, and the system does not send a lane change confirmation request or takeover request, causing the wheel to cross a solid line or the vehicle to be subject to a forced takeover by the driver;
- Any running wheel of the SV crosses the diversion area.

### **A.6 Highway on-ramp**

a) Level 1 (scoring rate: 100%): The SV can identify the surrounding vehicle in the same lane or the adjacent lane, and can completely merge into the main road of the highway from the ramp, without functional degradation or driver takeover alarm. In addition, when the SV starts lane change or the system prompts the driver to confirm lane change, the wheel does not cross a solid line or diversion line, and the THW between the front of the SV and the end of the acceleration lane is not less than 5 s.

b) Level 2 (scoring rate: 60%): The SV can identify the surrounding vehicle in the same lane or the adjacent lane, and when the THW between the front of the SV and the end of the acceleration lane is not less than 5 s, the system sends a takeover request, and the driver completes the lane change.

c) Level 3 (no points): If one of the following conditions is met, it is considered that the scoring requirements of this level are met:

- When the SV starts lane change or the system prompts the driver to confirm lane change, the THW between the front of the SV and the end of the acceleration lane is less than 5 s;
- The system sends a takeover request, but the THW between the front of the SV and the end of the acceleration lane is less than 5 s at this time;
- The SV fails to identify the surrounding vehicle in the same lane or the adjacent lane, and the driver is forced to take over in the event of risk of collision during lane change;
- The SV does not change its lane to the main road of the highway and the system does not send a lane change confirmation request or takeover request, causing the wheel to cross a solid line or the vehicle to be subject to a forced takeover by the driver or to enter the emergency lane.